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EXQ60 48V SERIES

Dual output

Jameco Part Number 218894

- High efficiency topology, 91.5% typical at 5V/3.3V
- High output current, high useable power density
- Industry standard footprint
- Wide operating temperature, -40˚C to +100˚C (baseplate temperature)
- 90% to 110% output trim
- No minimum load
- Overvoltage protection
- Remote on/off
- Approvals to EN60950 (TÜV Rheinland) and UL/cUL1950
- Complies with ETS 300 019-1-3/2-3
- Complies with ETS 300 132-2 (input voltage and current requirements)
- Complies with ETS 300 386-1

The EXQ60 is a new high efficiency, open-frame, isolated 60 Watt converter series in an industry standard quarter-brick footprint. The EXQ60 delivers very high output current at low voltages, dual outputs, and excellent useable power density for today's high-end applications. The design takes advantage of open-frame construction to provide a low mass, low thermal impedance baseplate design. The simplicity of the baseplate design enables customers to easily manage cooling of the product, eliminating the guesswork associated with competing products. The first two models in the series feature an input voltage range of 33 to 75VDC and are available in output voltages of 5V/3.3V and 3.3V/2.5V. The output voltage on each model is adjustable from 90% to 110% of the nominal value. Typical efficiencies for the models are 91.5% for the 5V/3.3V and 90.5% for the 3.3V/2.5V version. The EXQ60 series also has a remote on/off capability. Overcurrent and overvoltage protection features are included as standard. With full international safety approval including EN60950 (TÜV Rheinland) and cUL1950, the EXQ60 reduces compliance costs and time to market.

[2 YEAR WARRANTY]

c US TÜV

ARTESYN® TECHNOLOGIES

Stresses in excess of the maximum ratings can cause permanent damage to the device. Operation of the device is not implied at these or any other conditions in excess of those given in the specification. Exposure to absolute maximum ratings can adversely affect device reliability.

Absolute Maximum Ratings

Characteristic	Symbol	Min	Typ	Max	Units	Notes and Conditions
Input voltage - continuous	V_{in} (cont)	-0.3		75	V DC	$V_{in}(+)$ - $V_{in}(-)$
Input voltage - peak/surge	V_{in} (peak)	-0.3		100	V DC	Peaks of any duration Converter OFF above 80V, non latching, unit ON once Vin <75V
Input Voltage - remote pin	V_{rem} (peak)	-0.3		75	V DC	Peaks of any duration
Operating temperature	Top	-40		100	˚C	Measured at thermal reference point, see Application Note 117 for details
Storage temperature	$T_{storage}$	-40		125	˚C	
Output power (5V/3.3V)	P_{out} (max)			60	W	
Output power (3.3V/2.5V)	P_{out} (max)			40	W	

All specifications are typical at nominal input Vin = 48V, full load under any resistive load combination at 25˚C unless otherwise stated.

Input Characteristics

Characteristic	Symbol	Min	Typ	Max	Units	Notes and Conditions
Input voltage - operating	V_{in} (oper)	33	48	75	V DC	
Input current - no load	I_{in}		54	60	mADC	$V_{in\ (min)}$ - $V_{in\ (max)}$, enabled
Input current - Quiescent	I_{in} (off)		13	20	mADC	Converter disabled
Input voltage variation	dv/dt			5	V/ms	Complies with ETS300 132 Part 4.4
Inrush current (i^2t)	Inrush		0.02		A^2s	Complies with ETS300 132 Part 4.7, with recommended LISN and recommended external bypass capacitor
Inrush current ratio	I_t/I_m		15			Complies with ETS300 132 Part 4.7, with recommended LISN and recommended external bypass capacitor
Input ripple rejection			70		dB	Frequency <1 kHz
Input fuse				5	A	Slow blow/antisurge HRC recommended 200V Rating

Turn On/Off

Characteristic	Symbol	Min	Typ	Max	Units	Notes and Conditions
Input voltage - turn on	V_{in} (on)	31	33	35	V DC	
Input voltage - turn off	V_{in} (off)	28	30	32	V DC	
Hysteresis			3		V DC	
Turn on delay - enabled, then power applied	T_{delay} (power)		8	10	msec	With the Remote On/Off signal asserted, time from when V_{in} > V_{in} (oper) until Vout is within total regulation band
Turn on delay - power applied, then enabled	T_{delay} (enable)		3	4	msec	With V_{in} = $V_{in\ (nom)}$, then Remote On/Off asserted, time until Vo within total error band
Rise time	T_{rise}		1.0	2.0	msec	From 10% to 90%, full resistive load, no external capacitance

Signal Electrical Interface

Characteristic - Signal Name	Symbol	Min	Typ	Max	Units	Notes and Conditions
At remote/control ON/OFF pin						**See Notes 1 and 2**
Open collector or equivalent compatible						See Application Note 117 for remote ON/OFF details
Control pin open circuit voltage	V_{ih}		4.5	5	V	I_{ih} = 0µA; open circuit voltage
High level input voltage	V_{ih}	4			V	Converter guaranteed ON when control pin is greater than V_{ih} (min)
High level input current	I_{ih}			10	µA	Current flowing into control pin when pin is pulled high (max. at V_{ih} = 75V)
Acceptable high level leakage current	I_{ih} (leakage)			-10	µA	Acceptable leakage current from signal pin into the open collector driver (neg = from converter)
Low level input voltage	V_{il}	0.3		1.2	V	Converter guaranteed OFF when control pin is < V_{il} (max)
Low level input current	I_{il}		-0.2	-0.4	mA	V_{il} = 0.4 V
Low level input current	I_{il} (max)		-0.2	-0.4	mA	V_{il} = 0.0 V, maximum source current from converter with short circuit

Common Protection/Control

Characteristic	Symbol	Min	Typ	Max	Units	Notes and Conditions
Overtemperature shutdown threshold	Tots	108	113	118	˚C	Baseplate temperature non-latching shutdown protection
Overtemperature shutdown restart hysteresis			4		˚C	
Remote sense compensation				N/A	%	No remote sense on EXQ60D

Reliability and Service Life

Characteristic	Symbol	Min	Typ	Max	Units	Notes and Conditions
Mean time between failure	MTBF	272,000			Hours	MIL-HDBK-217F, V_{in} = $V_{in\ (nom)}$; I_{out} = $I_{out\ (max)}$; ambient 25˚C; ground benign environment
Mean time between failure	MTBF	TBD			Hours	Demonstrated
Expected service life		TBD			Years	Pending
HALT testing						Completed
Asynchronous dynamic testing						Testing pending

Isolation

Characteristic	Symbol	Min	Typ	Max	Units	Notes and Conditions
Input to output test voltage				1500	V DC	Test duration 1s
Input to output capacitance			2000		pF	
Input to output resistance		100			MΩ	Measured with 500 V DC
Input to output insulation system			Operational			

Other Specifications

Characteristic	Symbol	Min	Typ	Max	Units	Notes and Conditions
Switching frequency	F_{sw}	340	400	460	kHz	EXQ60-48D05-3V3
		283	325	374	kHz	EXQ60-48D3V3-2V5
Weight			45	48	g	

Environmental Specifications

Characteristic	Symbol	Min	Typ	Max	Units	Notes and Conditions
Thermal performance		-40		100	˚C	Baseplate temperature
Altitude				3000	m	Derate total max. output current by 20%
				9843	ft	Derate total max. output current by 20%
				10000	m	Derate total max. output current by 50%
				32808	ft	Derate total max. output current by 50%

Type	Parameter	Reference	Test Level	Notes and Conditions
Air temperature	Low	IEC 68-2-1	-40˚C	All characteristics and parameters
	High	IEC 68-2-2	+70˚C	extracted from ETS 300 019
	Change	IEC 68-2-14	-40˚C to +70˚C	classes 3.1, 3.2, 3.3, 3.4 and 3.5
				$T_{max.}$ = +65˚C for T3.4
Relative humidity	Low		10%	
	High	IEC 68-2-56	100%	
	Condensation	IEC 68-2-30	90 to 100%	
Vibration IEC class 3M5	Freq. velocity	IEC 68-2-6	5-9Hz 5mm/s	
	Freq. acceleration	IEC 68-2-6	9-200Hz 1g	
Shocks IEC class 3M5	Acceleration	IEC 68-2-29	10g	

Referenced ETSI standards:

ETS 300 019: Environmental conditions and environmental tests for telecommunications equipment
ETS 300 019: Part 1-3 (1997) Classification of environmental conditions stationary use at weather protected locations
ETS 300 019: Part 2-3 (1997) Specification of environmental tests stationary use at weather protected locations

EMC
Electromagnetic Compatibility

Phenomenon	Port	Standard	Test level	Criteria	Notes and conditions
Immunity:					
ESD	Enclosure	EN61000-4-2	6kV contact	NP	As per ETS 300 386-1 table 5
			8kV air	RP	
EFT	DC power	EN61000-4-4	2kV	NP	As per ETS 300 386-1 table 5
			4kV	LFS	
	Signal	EN61000-4-4	1kV	NP	See Application Note 117
			2kV	LFS	See Application Note 117
Radiated field	Enclosure	EN61000-4-3	10V/m	NP	As per ETS 300 386-1 table 5
Conducted	DC power	EN61000-4-6	10V	NP	As per ETS 300 386-1 table 5
	Signal	EN61000-4-6	10V	NP	See Application Note 117
Input transients	DC power	ETS 300 132 ETR 283			

EMC
Electromagnetic Compatibility

Phenomenon	Port	Standard	Test level	Criteria	Notes and conditions
Emission:					
Conducted	DC power	EN55022	Level A		With recommended external filter for compliance bandwidth 20 kHz to 30 MHz, as per ETS 300 386-1. See Application Note 117 for details
		EN55022	Level B		With recommended external filter for compliance bandwidth 20 kHz to 30 MHz, as per ETS 300 386-1. See Application Note 117 for details
Radiated		EN55022	Class A (in enclosure)		Bandwidth 30 MHz to 1 GHz, as per ETS 300 386-1

Performance criteria:

NP: Normal Performance: EUT shall withstand applied test and operate within relevant limits as specified without damage
RP: Reduced Performance: EUT shall withstand applied test. Reduced performance is permitted within specified limits, resumption to normal performance shall occur at the cessation of the test
LFS: Loss of Function (self recovery): EUT shall withstand applied test without damage, temporary loss of function permitted during test. Unit will self recover to normal performance after test

Referenced ETSI standards:

ETS 300 386-1 table 5 (1997): Public telecommunication network equipment, EMC requirements
ETS 300 132-2 (1996): Power supply interface at the input to telecommunication equipment: Part 2 operated by direct current (DC)
ETR 283 (1997): Transient voltages at interface A on telecommunication direct current (DC) power distributions

Standards Compliance List

Characteristic	
EN60950 UL/cUL 1950 TÜV Rheinland	3rd edition

Safety Agency Approvals

Standard	Category
UL/cUL 1950 File Number	E135734
TÜV Rheinland Certificate No.	R2172506

Material Ratings

Characteristic	Notes and Conditions
Flammability rating	UL94V-0
Material type	FR4 PCB, T-LAM IMS - baseplate

Model Numbers

Model Number	Input Voltage	Output Voltage	Overvoltage Protection	Output Current (Max.)	Typical Efficiency
EXQ60-48D05-3V3	33-75 VDC	5V/3.3V	6V/4V	12A/15A	91.5%
EXQ60-48D3V3-2V5	33-75 VDC	3.3V/2.5V	4V/3V	12A/16A	90.5%

EXQ60-48D05-3V3 Model

Input Characteristics

Characteristic	Symbol	Min	Typ	Max	Units	Notes and Conditions
Input current - operating	I_{in}		1.37	1.4	A DC	$V_{in} = V_{in\ (nom)}$; $I_{out} = I_{out\ (max.)}$; $V_o = V_{o\ (nom)}$
Input current - maximum	$I_{in\ (max.)}$		2.02	2.05	A DC	$V_{in} = V_{in\ (min)}$; $I_{out} = I_{out\ (max.)}$; $V_o = V_{o\ (nom)}$, measured at converter
Input capacitor ripple current	$I_{in\ (ripple)}$		30 80	65 180	mA RMS mA pk-pk	$I_{out} = I_{out\ (max.)}$, measured with standard Filter. See Application Note 117 for details
Reflected ripple current	$I_{in\ (ref)}$		1 2.5	2 6	mA RMS mA pk-pk	$I_{out} = I_{out\ (max.)}$, measured with standard Filter. See Application Note 117 for details
Input capacitance - internal	C_{input}	2.4	3.0	5.4	µF	Internal to converter
Input capacitance - external bypass	C_{bypass}		33		µF	Recommended customer added capacitance, <0.7 Ohm ESR

EXQ60-48D05-3V3 Model

Electrical Characteristics - O/P

Characteristic	Symbol	Min	Typ	Max	Units	Notes and Conditions
Nominal set-point voltage	Vo (nom) 5V Vo (nom) 3.3V	4.94 3.270	5.00 3.308	5.06 3.47	V DC V DC	Vin = Vin (Nom); $I_{out} = I_{out\ (nom)}$
Total regulation band	Vo 5V Vo 3.3V	4.75 3.20		5.23 3.43	V DC V DC	For all line, static load and temperature until end of life
Output current continuous	Iout 5V Iout 3.3V	0 0		12.00 15.00	A DC A DC	Total output power must not exceed 60W
Output current - short circuit	$I_{sc\ 5V}$ $I_{sc\ 3.3V}$	9.6 14.4	14.00 21.00	16.00 24.00	A rms A rms	Continuous, unit auto recovers from short, V_o < 100mV
Load transient response - peak deviation	$V_{dynamic\ 5V}$ $V_{dynamic\ 3.3V}$		120 70	180 100	mV mV	Peak deviation for 50% to 75% step load, di/dt = 100mA/µsec
Load transient response - recovery	$T_{recovery}$		50	100	µsec	Settling time to within 1% of output set point voltage for 50% to 75% load step
External load capacitance	$C_{ext\ (5V)}$ $C_{ext\ (3.3V)}$	0 0		1,000 3,300	µF µF	Higher load capacitance values may be possible. Contact Artesyn Technologies for details

EXQ60-48D05-3V3 Model

Protection and Control Features

Characteristic	Symbol	Min	Typ	Max	Units	Notes and Conditions
Overvoltage clamp voltage	$V_{ov\ 5V}$ Vov 3.3V	5.7 3.8	5.9 4.0	6.2 4.2	V DC V DC	Non-latching. See Application Note 117 for details
Overcurrent limit inception	$I_{oc\ 5V}$ $I_{oc\ 3.3V}$	13.0 19.5	14.0 21.0	15 22.5	A DC A DC	V_O = 90% of $V_{O\ (nom)}$ V_O = 90% of $V_{O\ (nom)}$
Output voltage trim range		 90		110	% %	Trim up (% of $V_{O\ nom}$) Trim down (% of $V_{O\ nom}$) See Application Note 117 for details of trim equations and trim curves

EXQ60-48D05-3V3 Model

Efficiency

Characteristic	Symbol	Min	Typ	Max	Units	Notes and Conditions
Efficiency	η	90.5	91.5		%	$I_{out\ 5V}$ = 50% Iout (max), $I_{out\ 3.3V}$ = 50% Iout (max), V_{in} = $V_{in\ (nom)}$
Efficiency	η	89	90		%	$I_{out\ 5V}$ = 25% $I_{out\ (max)}$, $I_{out\ 3.3V}$ = 25% $I_{out\ (max)}$, V_{in} = $V_{in\ (nom)}$

EXQ60-48D3V3-2V5 Model

Input Characteristics

Characteristic	Symbol	Min	Typ	Max	Units	Notes and Conditions
Input current - operating	I_{in}		0.93	0.94	ADC	$V_{in} = V_{in\ (nom)}$; $P_{out} = P_{out\ (max.)}$; 50% each output
Input current - maximum	$I_{in\ (max.)}$		1.35	1.37	ADC	$V_{in} = V_{in\ (min)}$; $P_{out} = P_{out\ (max.)}$; 50% each output
Input capacitor ripple current	$I_{in\ (ripple)}$		30 90	70 190	mA RMS mA pk-pk	$I_{out} = I_{out\ (max.)}$, measured with standard Filter. See Application Note 117 for details
Reflected ripple current	$I_{in\ (ref)}$		1 3	8 5.4	mA RMS mA pk-pk	$I_{out} = I_{out\ (max.)}$, measured with standard Filter. See Application Note 117 for details
Input capacitance - internal filter	C_{input}	2.4	3.0	5.4	µF	Internal to converter
Input capacitance - external bypass	C_{bypass}		33		µF	Recommended customer added capacitance, <0.7 Ohm ESR

EXQ60-48D3V3-2V5 Model

Electrical Characteristics - O/P

Characteristic	Symbol	Min	Typ	Max	Units	Notes and Conditions
Nominal set-point voltage	Vo (nom) 3.3V Vo (nom) 2.5V	3.300 2.470	3.341 2.500	3.381 2.523	V DC V DC	Vin = Vin (Nom); $I_{out} = I_{out\ (nom)}$
Total regulation band	Vo 3.3V Vo 2.5V	3.179 2.390		3.475 2.600	V DC V DC	For all line, static load and temperature until end of life
Output current continuous	I_{out} 3.3V I_{out} 2.5V	0.000 0.000		12 16	A DC A DC	Total output power must not exceed 40W
Output current - short circuit	I_{sc} 3.3V I_{sc} 2.5V		12 16	16 21	A rms A rms	Continuous, unit auto recovers from short, V_o < 100mV
Load transient response - peak deviation	$V_{dynamic}$ 3.3V $V_{dynamic}$ 2.5V		100 70	150 100	mV mV	Peak deviation for 50% to 75% step load, di/dt = 100mA/µsec
Load transient response - recovery	$T_{recovery}$		40	100	µsec	Settling time to within 1% of output set point voltage for 50% to 75% load step
External load capacitance	$C_{ext\ (3.3V)}$ $C_{ext\ (2.5V)}$	0 0		2,200 3,300	µF µF	Higher load capacitance values may be possible. Contact Artesyn Technologies for detail

EXQ60-48D3V3-2V5 Model

Protection and Control Features

Characteristic	Symbol	Min	Typ	Max	Units	Notes and Conditions
Overvoltage clamp voltage	V_{ov} 3.3V Vov 2.5V	3.8 2.8	4.0 3.0	4.2 3.2	V DC V DC	Non-latching. See Application Note 117 for details
Overcurrent limit inception	I_{oc} 3.3V I_{oc} 2.5V	13 17.3	14.0 18.7	15 20	A DC A DC	V_o = 90% of $V_{o\ (nom)}$
Output voltage trim range		 90		110	%	Trim up (% of $V_{o\ nom}$) Trim down (% of $V_{o\ nom}$) See Application Note 117 for details of trim equations and trim curves

EXQ60-48D3V3-2V5 Model

Efficiency

Characteristic	Symbol	Min	Typ	Max	Units	Notes and Conditions
Efficiency	η	89.5	90.5		%	$I_{out\ 3.3V}$ = 50% $I_{out\ (max)}$, $I_{out\ 2.5V}$ = 50% $I_{out\ (max)}$, $V_{in} = V_{in\ (nom)}$
Efficiency	η	89	90		%	$I_{out\ 3.3V}$ = 25% $I_{out\ (max)}$, $I_{out\ 2.5V}$ = 25% $I_{out\ (max)}$, $V_{in} = V_{in\ (nom)}$

EXQ60-48D3V3-2V5 Model

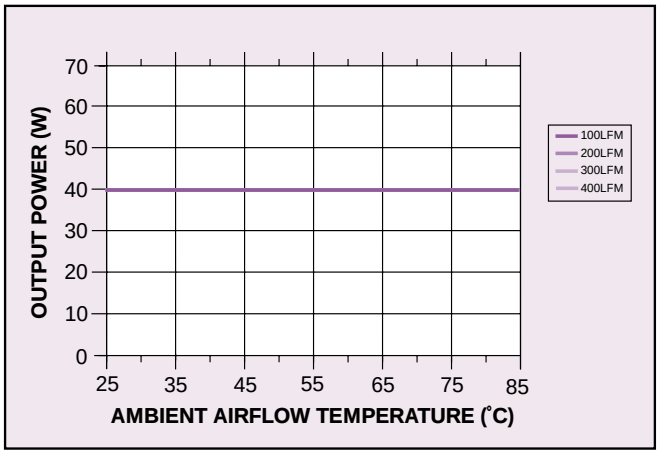


Figure 1.1: Maximum Output Power vs. Ambient Temperature and Airflow with 50% Load Split

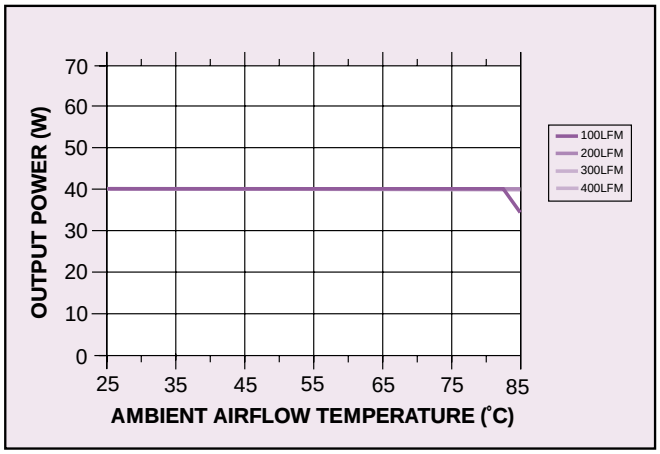


Figure 1.2: Maximum Output Power vs. Ambient Temperature and Airflow with 100% Load from Vout1

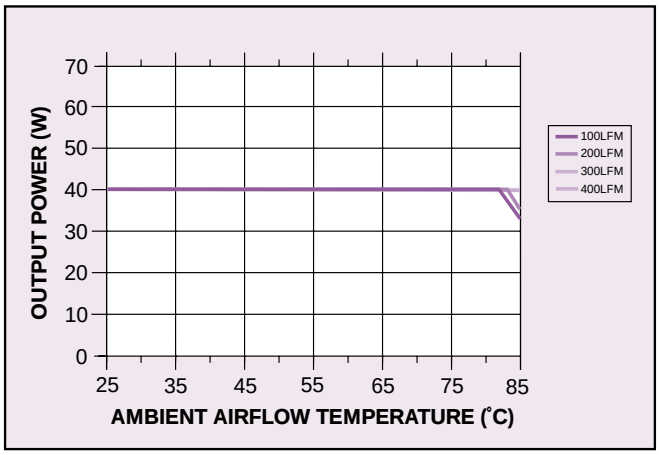


Figure 1.3: Maximum Output Power vs. Ambient Temperature and Airflow with 100% Load from Vout2

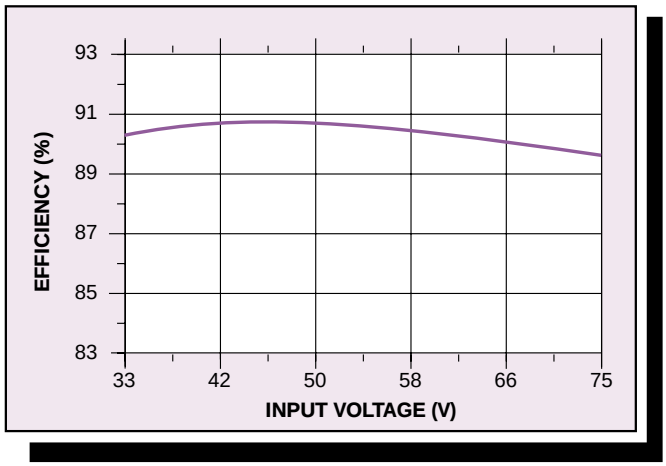


Figure 2: Efficiency vs. Line

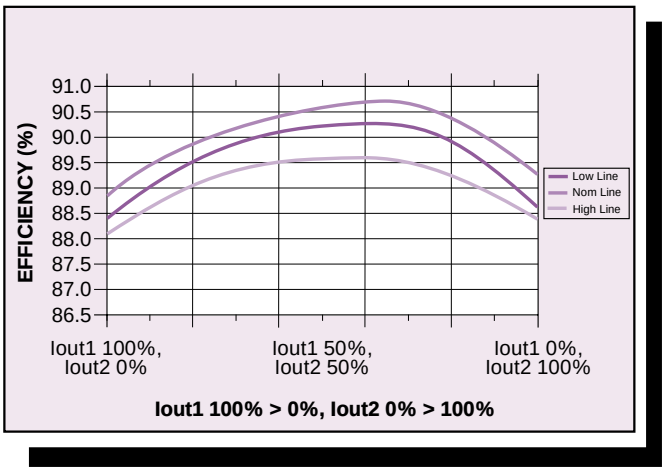


Figure 3: Efficiency vs. Crossload

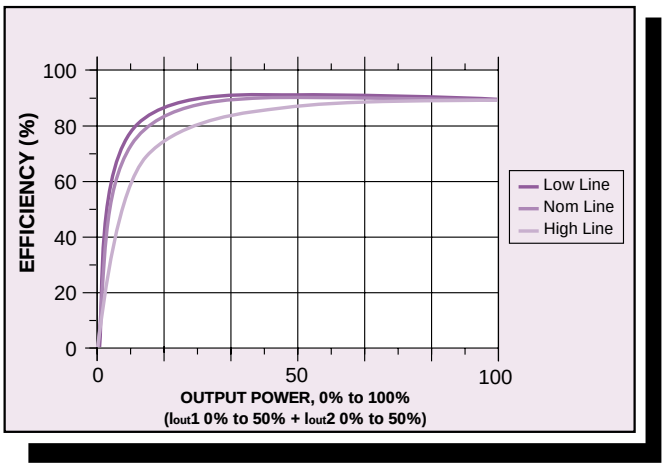


Figure 4: Efficiency vs. Load

EXQ60-48D3V3-2V5 Model

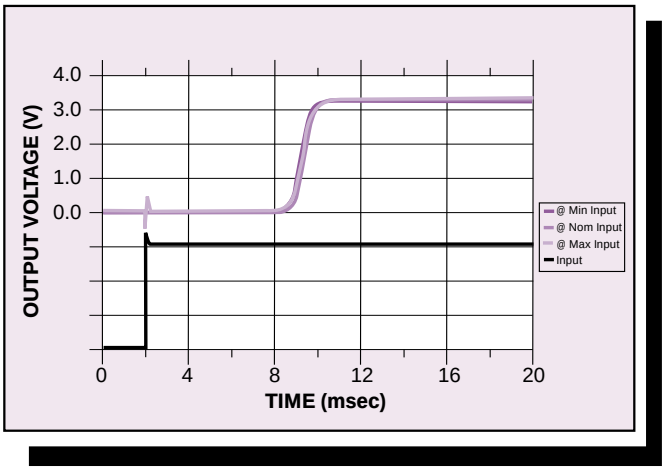


Figure 5: Typical Start-up (Vout1)

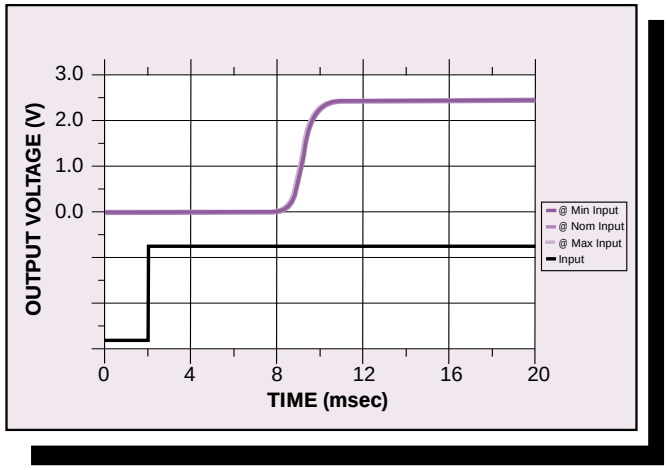


Figure 6: Typical Start-up (Vout2)

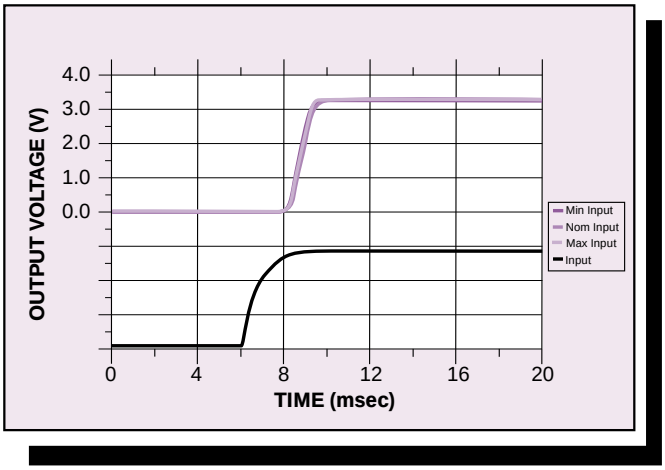


Figure 7: Remote ON/OFF Control (Vout1)

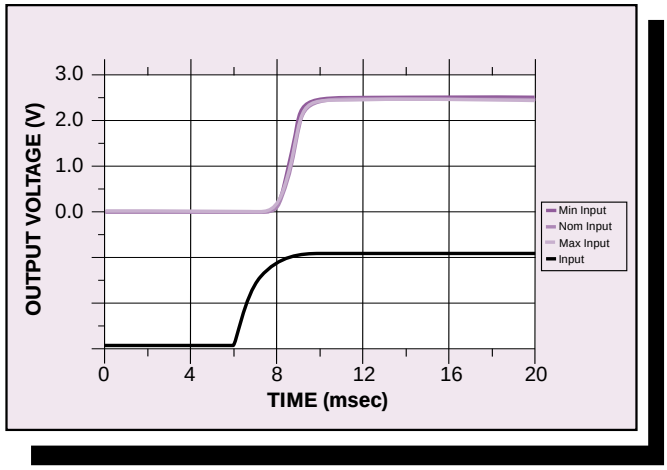


Figure 8: Remote ON/OFF Control (Vout2)

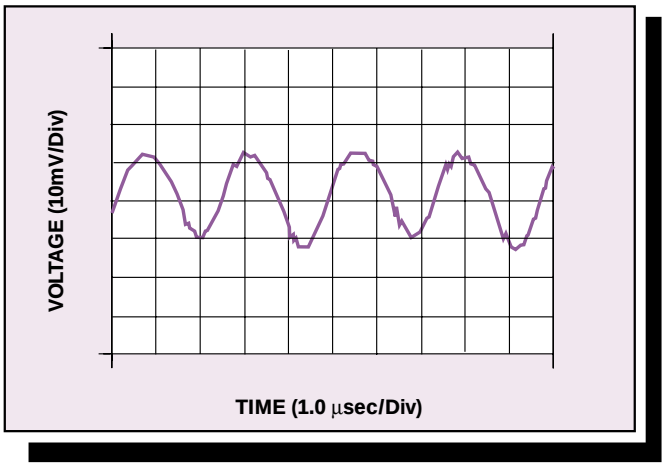


Figure 9: Output Ripple (Vout1)

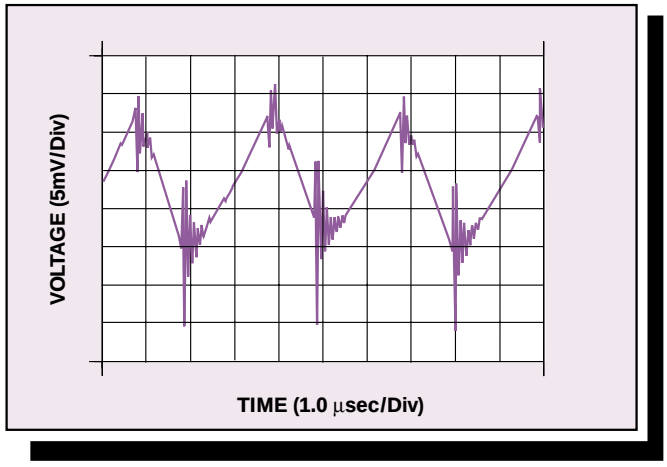


Figure 10: Output Ripple (Vout2)

EXQ60-48D3V3-2V5 Model

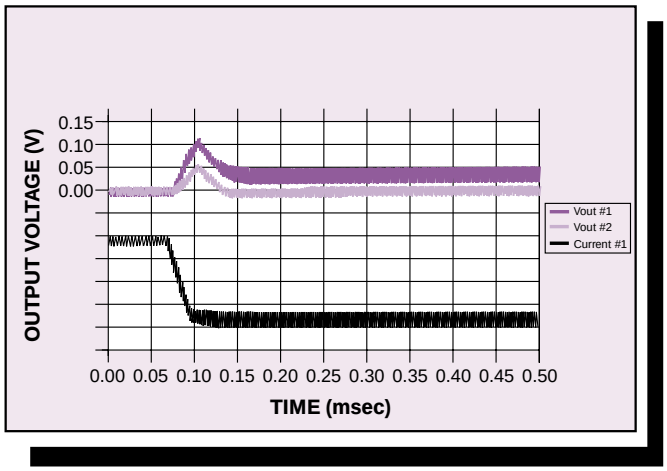


Figure 11: Typical Transient Response 75%-50%, Step Load Change

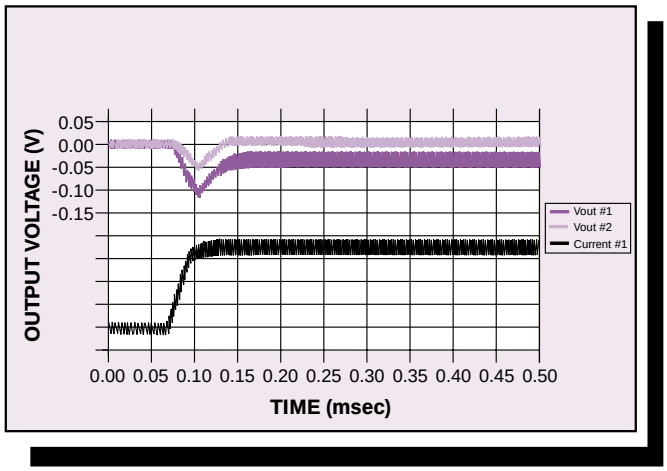


Figure 12:Typical Transient Response 50%-75%, Step Load Change

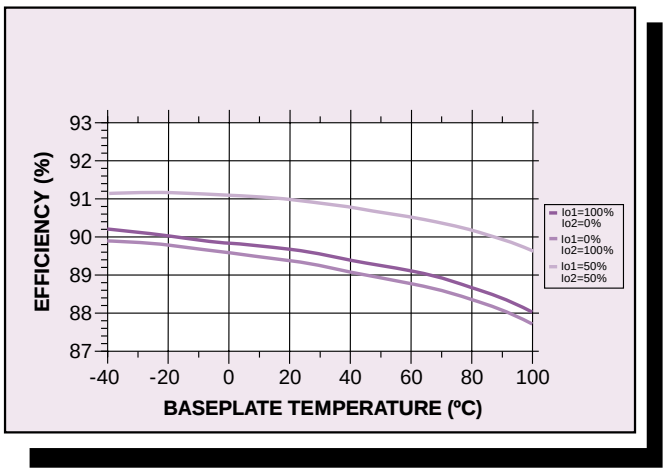


Figure 13: Typical Efficiency vs. Baseplate Temperature

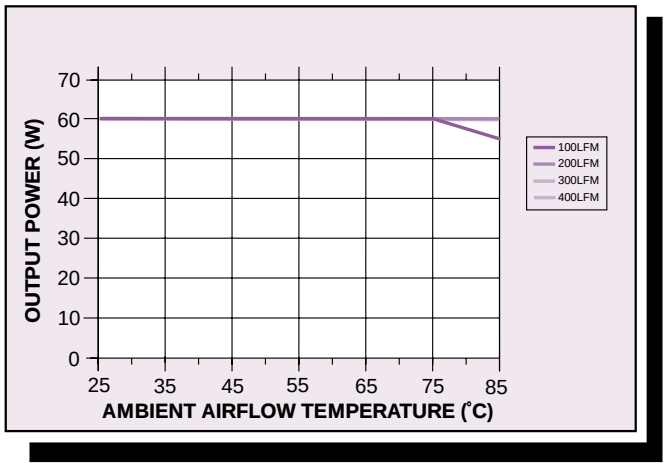


Figure 14.1: Maximum Output Power vs. Ambient Temperature and Airflow with 50% Load Split

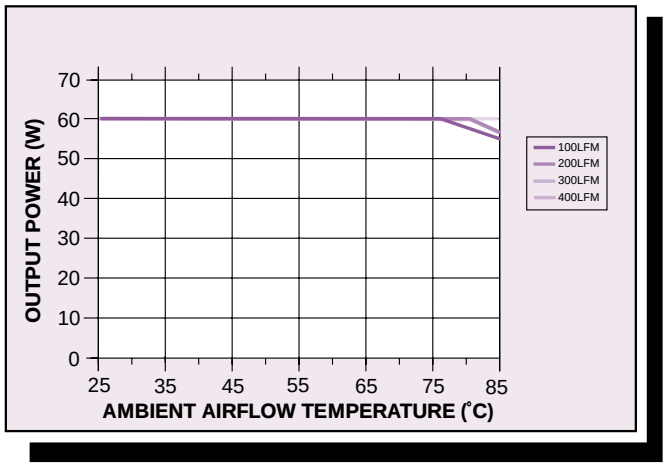


Figure 14.2: Maximum Output Power vs. Ambient Temperature and Airflow with 100% Load from Vout1

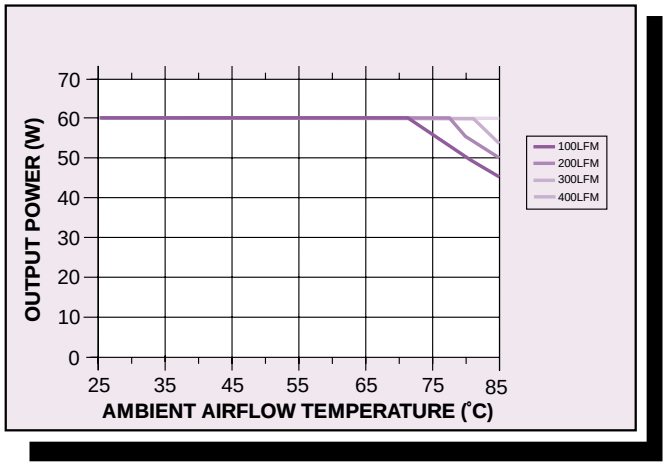


Figure 14.3: Maximum Output Power vs. Ambient Temperature and Airflow with 100% Load from Vout2

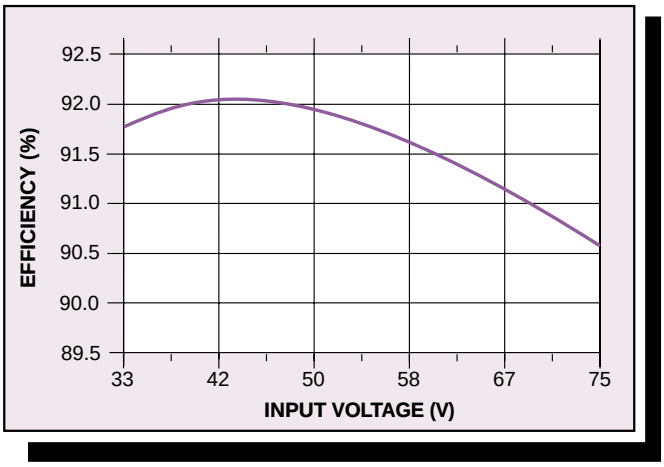


Figure 15: Efficiency vs. Line

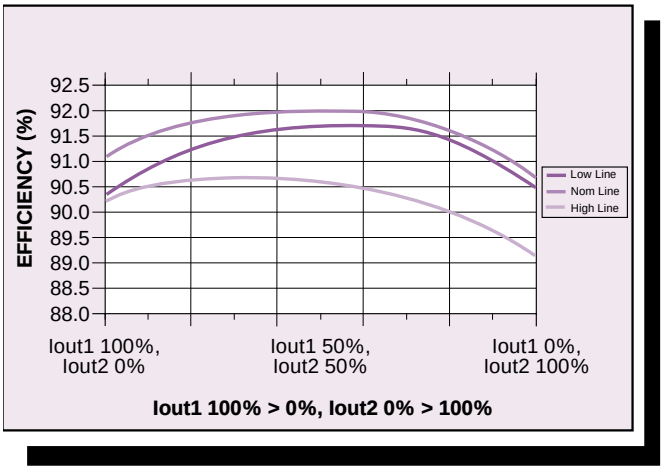


Figure 16: Efficiency vs. Crossload

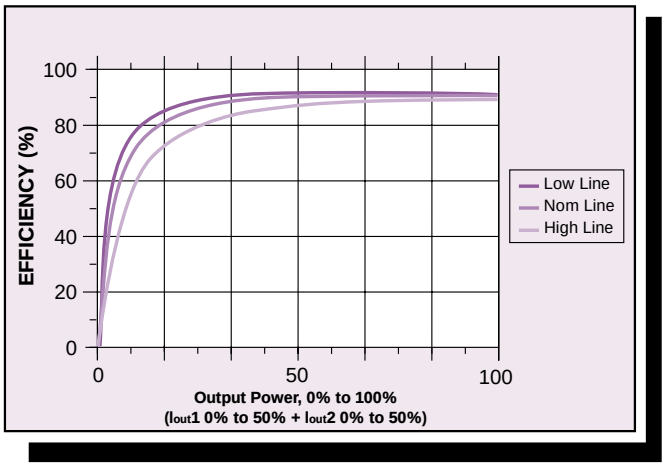


Figure 17: Efficiency vs. Load

EXQ60-48D05-3V3 Model

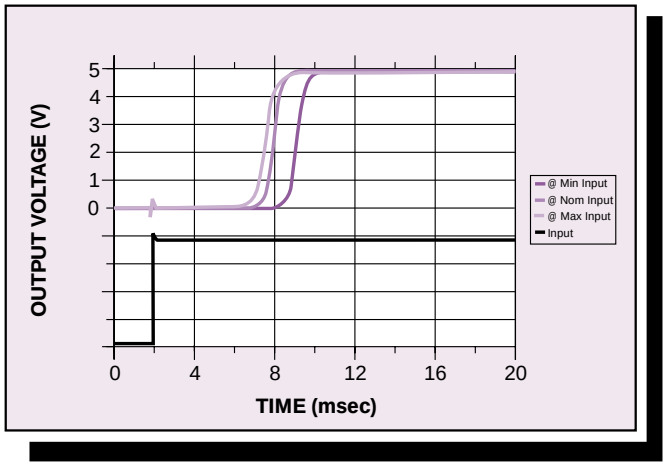


Figure 18: Typical Start-up (Vout1)

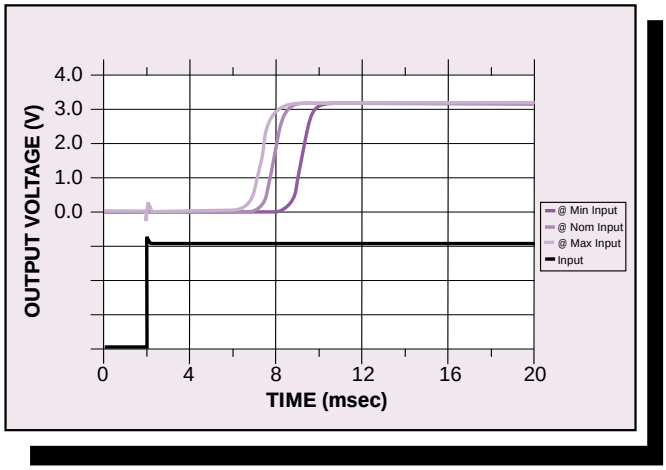


Figure 19: Typical Start-up (Vout2)

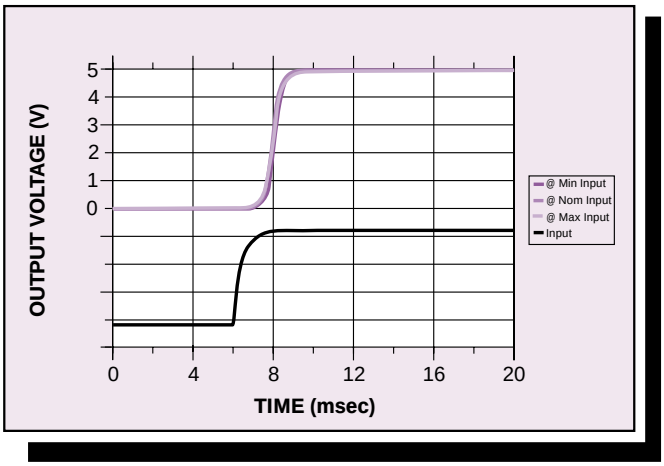


Figure 20: Remote ON/OFF Control (Vout1)

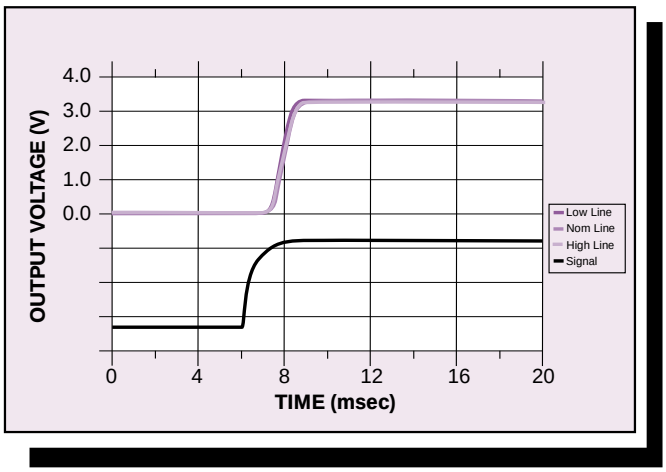


Figure 21: Remote ON/OFF Control (Vout2)

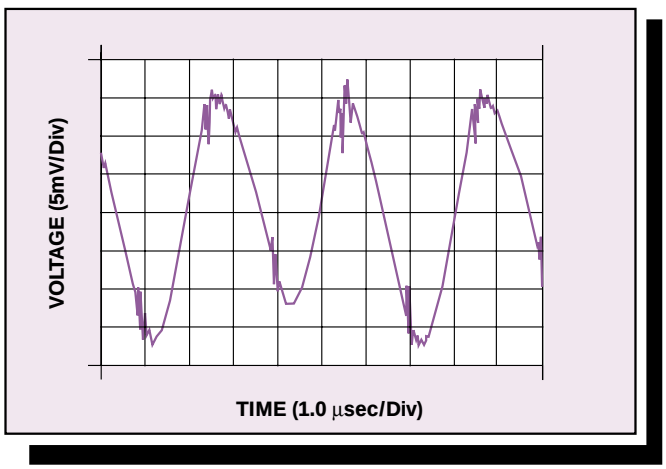


Figure 22: Output Ripple (Vout1)

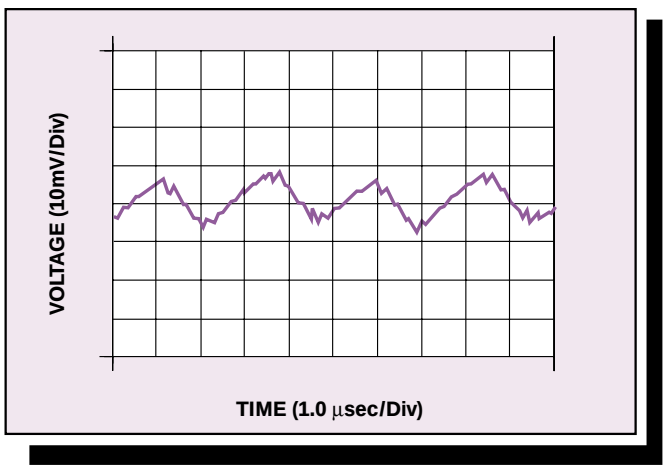


Figure 23: Output Ripple (Vout2)

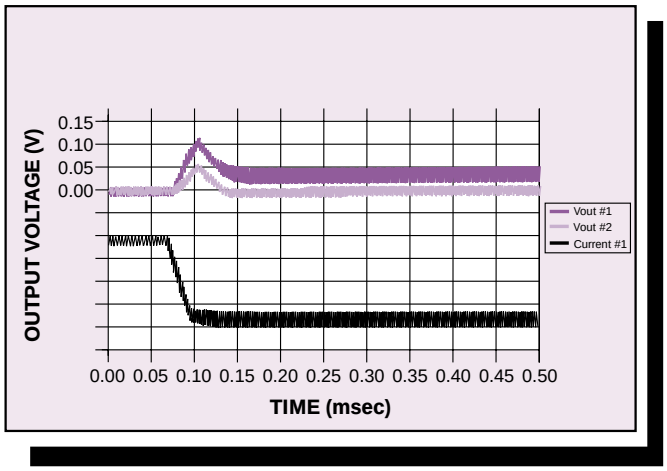


Figure 24: Typical Transient Response 75%-50%, Step Load Change

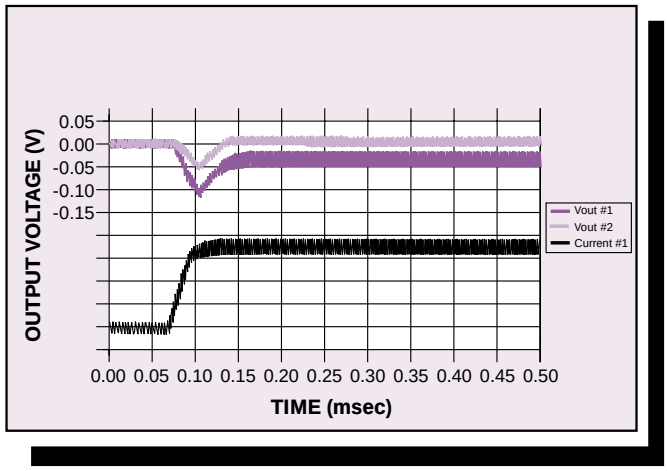


Figure 25: Typical Transient Response 50%-75%, Step Load Change

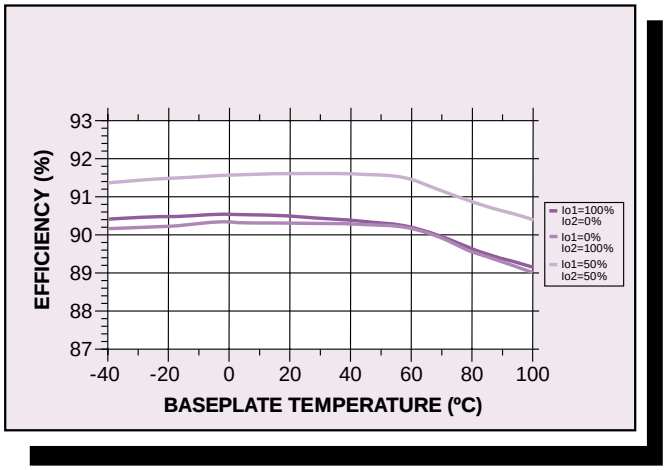
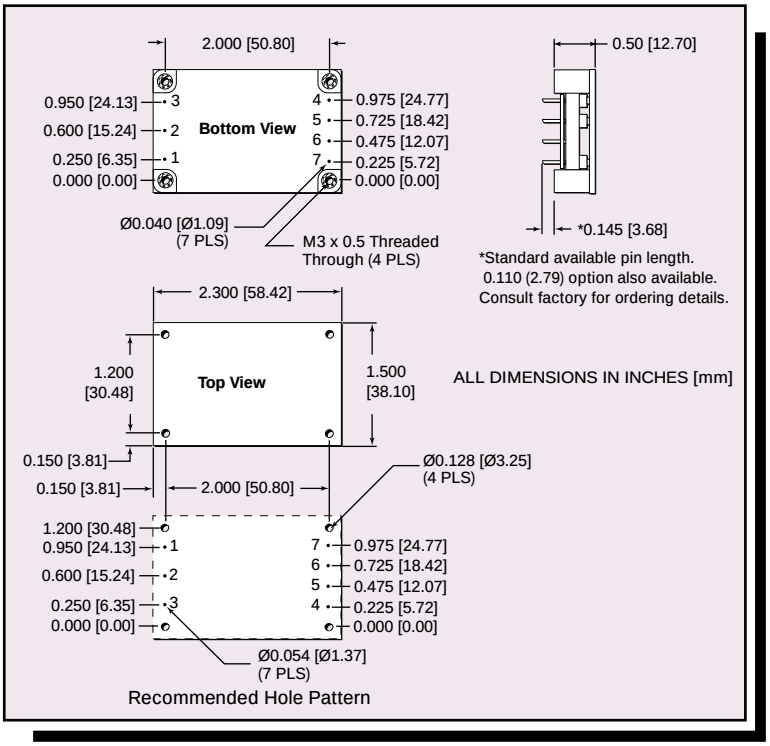


Figure 26: Typical Efficiency vs. Baseplate Temperature

INPUT VOLTAGE	OUTPUT VOLTAGE		OUTPUT CURRENT		OVP		TYPICAL EFFICIENCY	MODEL NUMBER (2)
	OP1	OP2	1	2	1	2		
33-75VDC	5V	3.3V	12.0A	15.0A	5.9V	4.0V	91.5%	EXQ60-48D05-3V3
33-75VDC	3.3V	2.5V	12.0A	16.0A	4.0V	3.0V	90.5%	EXQ60-48D3V3-2V5



Pin Connections

Pin No.	*Function*
1	+ Vin
2	ON/OFF
3	- Vin
4	OP2
5	Output Return
6	Trim
7	OP1

Figure 27: Dimensions and Pinout

Note 1

The control pin is referenced to Vin-.

Note 2

Active low Remote ON/OFF is available. Standard product is active high. When ordering active low parts, designate with the Suffix '-R' e.g. EXQ60-48D05-3V3-R. See Application Note 117 for detailed information regarding ON/OFF control implementation.

CAUTION: Hazardous internal voltages and high temperatures. Ensure that unit is accessible only to trained personnel. The user must provide the recommended fusing in order to comply with safety approvals.

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